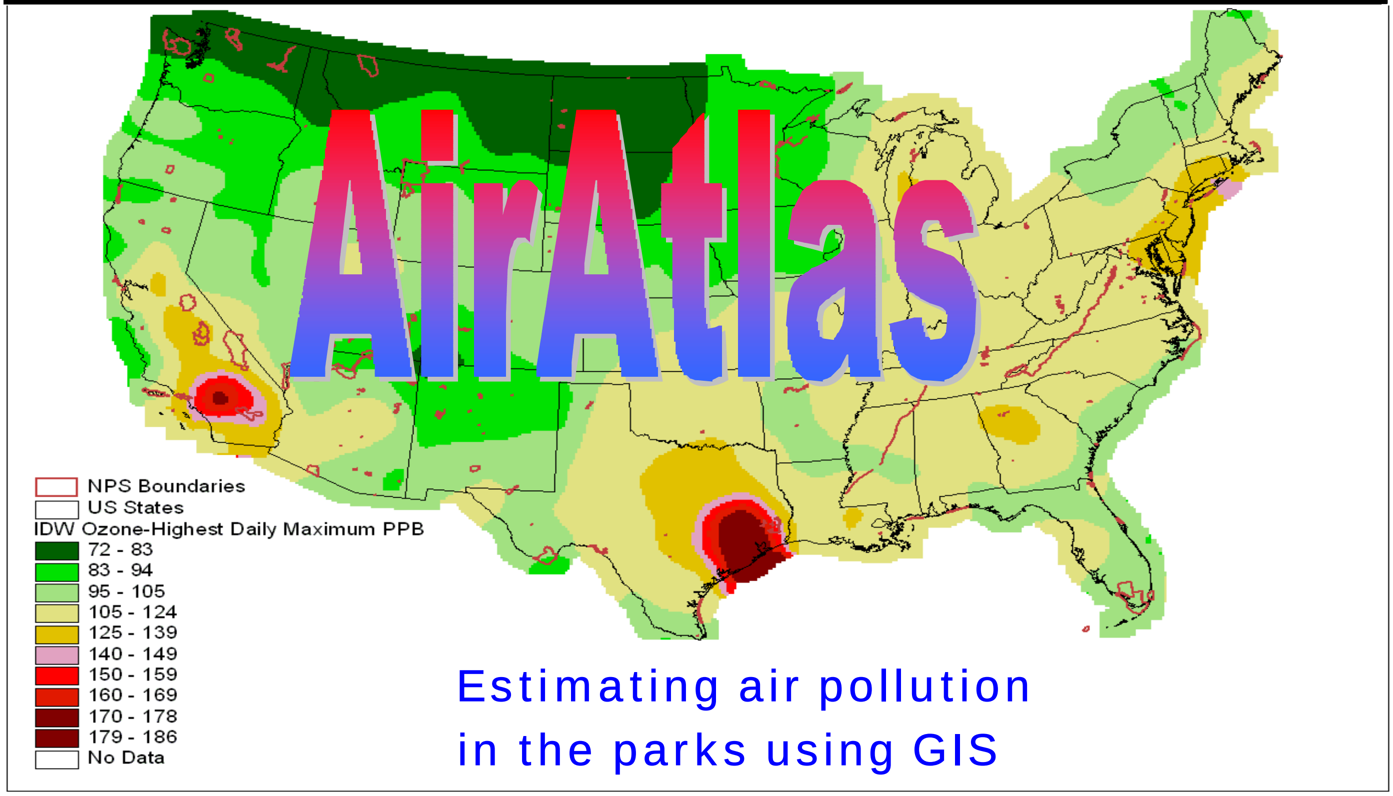
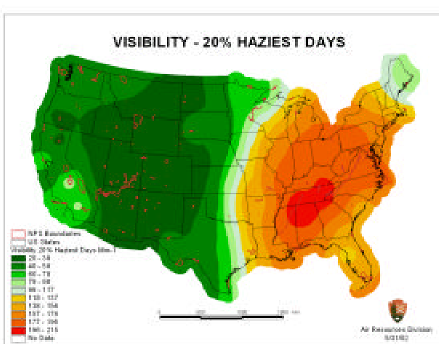
National Park Service
U.S. Department of the Interior

Air Resources Division



A cost-effective way to determine current air quality and if additional monitoring is needed.

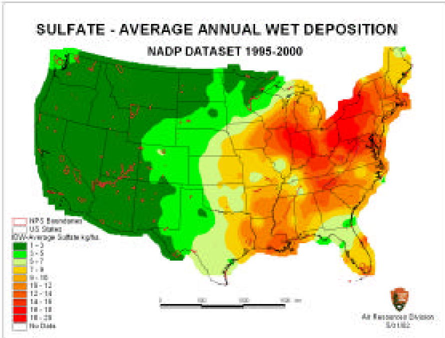


Hazy days visibility estimates.

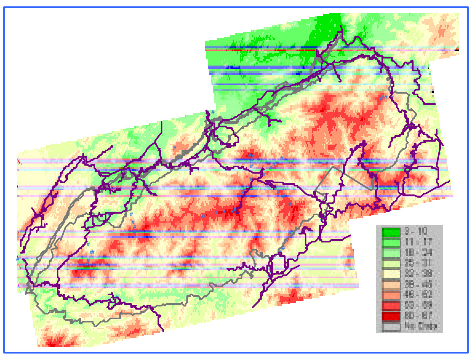
Background
One usually thinks of the Parks as havens from civilization where nature prevails and scenic vistas and clean air are the norm. In recent years, we have found that air pollution haze blocks the views in some of the most scenic parks and air quality can be as bad as in the urban areas miles away. The Inventory and Monitoring (I&M) Program would like to determine the air quality conditions in over 270 National Parks. Yet, measuring air quality and visibility can be an intensive effort, expensive, and take many years. At present, there is full NPS-sponsored air monitoring in only about 50 parks and partial monitoring in another 50. The dilemma is how to inventory the air resources in so many parks with limited funds.

The Air Resources Division (ARD) has been monitoring air quality, atmospheric pollutant deposition, and visibility in the parks since the 1980's. These monitoring efforts are often carried out in partnership with national networks of monitoring stations. Air pollution mixes in the atmosphere and has a persistence of days and weeks in the lower atmosphere. Therefore, it was thought that interpolation methods could be used to estimate air pollutant concentrations.

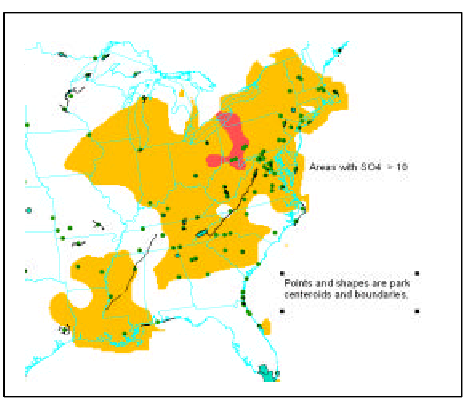
Geographic Information Systems (GIS)
Data from 5-years of monitoring was collected from all the national air monitoring networks. Statistical summaries were prepared and entered into a GIS database. Inverse distance-weighted and kriging techniques were applied to the data to make gridded estimates



Estimates of average annual wet deposition of sulfate.



Detailed ozone distribution map for summer 2000 at Great Smoky Mountains National Park, 30-m resolution. Red areas have higher ozone.



Locations of parks where the SO4 acidic deposition is the worst.

of air quality for the contiguous 48 states. These estimates were then contoured and color-coded for display in the GIS system, ArcView. The result is color maps of air quality estimates with the locations of I&M park units shown on the maps. Maps are available for several ozone statistics: the acidic wet deposition species of SO4, NO3, NH4, Cl, Ca, Na, K; visibility indicators; particulates as PM2.5; and concentrations of SO4, NO3, and SO2 in the air. The locations of monitoring stations were also mapped and the ones in proximity to parks identified.

In some cases, nearby monitoring stations may be good indicators of air quality in the associated park and may have a longer record than the 5-years used for the GIS mapping. All the I&M parks in the contiguous 48 states had the estimated air quality read from the various maps and assembled into a table of values for easy lookup. This should fill the needs for a baseline air quality inventory. The uncertainty in the estimates was then determined and classified into three broad categories. The quality of the estimates are determined by the density of nearby monitoring stations, the spatial coverage of the stations, the complexity of the terrain, and the local variability of climate parameters.

Greater detail in the interpolation mapping may be possible. An intensive study with over 60 temporary monitoring sites was done in Great Smoky Mountains National Park to see how ozone could be interpolated in complex topological terrain. The detailed maps of ozone concentration illustrate that other closely related factors can be used to enhance the basic pollutant interpolations. Using techniques known as co-factor co-kriging, more detailed maps are possible that can estimate variation in pollutants within some of the larger parks. This work is still in the early stages, but promises to give enough detail to be of use with other GIS layers such as vegetation and waterways.

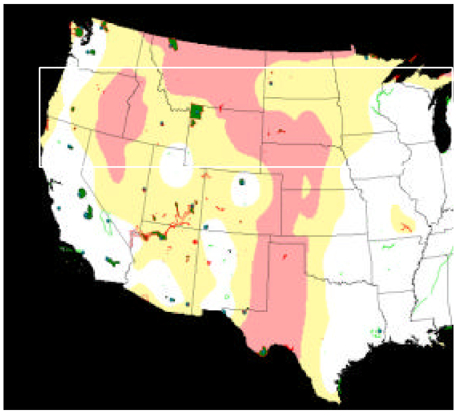
Other possibilities for this GIS approach to estimating air quality include future updates, trends, and consideration of the effects of multiple pollutants. Greater detail may also be needed in some areas. For example, multiple values at intervals may be needed for lengthy park units such as scenic roadways or trails. A commitment to an on-going effort will be needed for the GIS products to remain current.

Where is Monitoring Needed?

Several products from the air quality GIS effort can be useful for deciding where additional monitoring data is needed. Parks where the air quality estimates exceed EPA national standards will have to have direct monitoring to confirm the estimates. Other factors like the uncertainty in the estimates, rapid changes in local population or emissions sources, increasing trends in pollutant concentrations, the presence of known sensitive species, or absence of nearby monitors can be considered. ARD is putting these factors into the GIS as layers and will make them available for decision making.

Making the Information Accessible

The GIS interpolation project has created many maps and tables of information, too much to easily use if the GIS software and expertise aren't available locally. Therefore, a web-base product was built called "AirAtlas" that is a mini-GIS tool on the Internet with the results from the project. All the maps are viewable and the user can zoom into the region or park of interest. A query tool allows the user to get a table of the estimated air quality parameters for an individual park or a selection of several. The AirAtlas makes the air quality inventory available and accessible.



Pink and yellow areas have greater uncertainty in the ozone estimates

Air Quality Information

Data products and results are still being posted to the web pages, but much of it is available now. A hardcopy report of the air quality estimation maps is being produced also.

AirAtlas (interactive GIS)

Air quality maps and tables of values in parks. Links to other mapping resources on the web
http://www2.nature.nps.gov/ard/gas/airatlas-du/viewer_index.htm

or on the NPS IntraNet at
http://www2.nrintra.nps.gov/ard/index.htm

Tables of ozone exceedances
http://www2.nature.nps.gov/ard/gas/exceed.htm
New monitoring plans and lists of parks with nearby monitors that may be useful.
http://www2.nrintra.nps.gov/ard/gas/NRC_AQ_mon1.htm

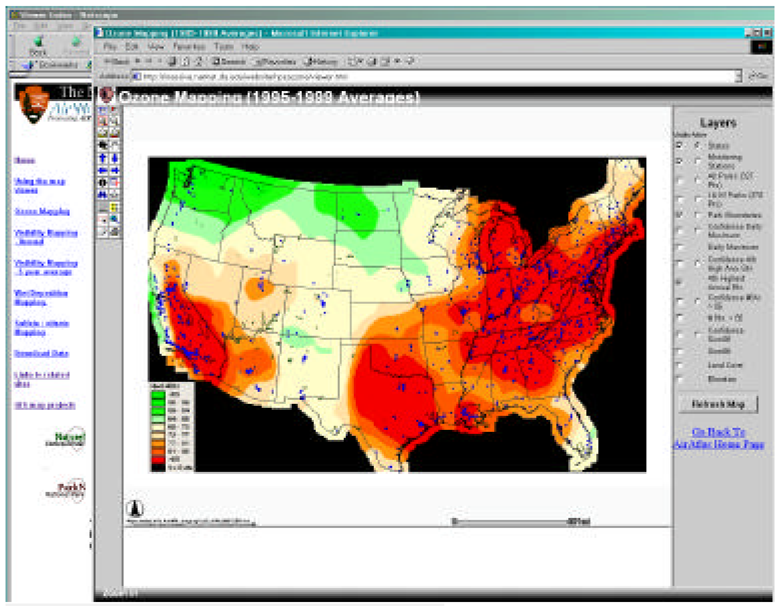
Maps of monitoring locations in the national monitoring networks

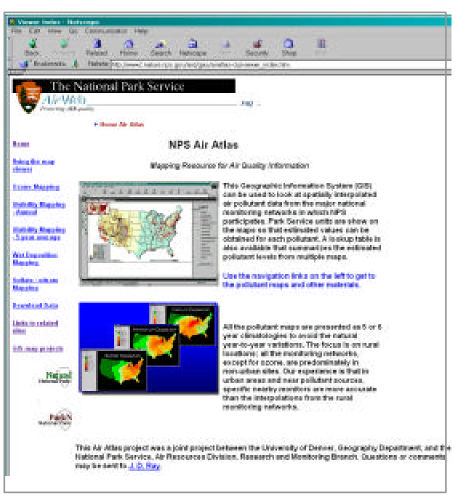
http://www2.nrintra.nps.gov/ard/gas/monitoringtab5.pdf

or

http://www2.nature.nps.gov/ard/gas/airatlas-du/viewer_index.htm

The AirAtlas, a web-based GIS map viewer.





Entry page to AirAtlas web site.

Monitoring Data Summaries

Annual and multiple-year reports of in-park monitoring data are available.
http://www2.nature.nps.gov/ard/

Detailed hourly or sample data
http://www2.nature.nps.gov/ard/gas/netdata1.htm

Database record of all NPS air quality monitoring
http://www2.nature.nps.gov/ard/monhist/aqsites.cfm

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